Since Spring 2023, I have been the primary investigator on a project that explores student responses to and the effectiveness of standards-based assessment (SBA) in Dr. Bonham's Introduction to Physics and Biophysics I course with mentorship from Dr. Bonham. SBA is a form of mastery learning where students are provided with feedback and allowed to reassess specific learning objectives (Bloom, 1968; Zimmerman, 2017). We have been particularly interested in changes in student self-efficacy, a measure of one's personal beliefs about their abilities to complete tasks since mastery experiences like those that SBA provides are hypothesized to be strong contributors to self-efficacy (Bandura, 1977). This positive self-efficacy is correlated to students' motivation to learn and persist when challenged, both of which are important in introductory physics. We have also been exploring how other aspects of the assessment and instruction impact student learning through the analysis of student coursework, primarily quizzes and retake requests. Through a better understanding of this implementation of SBA, we hope to share methods for more effective physics instruction with the wider physics education community.

To explore the variables identified above we constructed a survey instrument that could be given before and after the course and created coding schemes to analyze student coursework where applicable. The most prominent feature of the survey instrument is a seven-question self-efficacy survey created and validated for this project. We also asked students about their prior physics experience and course expectations and opinions. I also created a coding scheme to analyze the quality of student work on quizzes and the quality of student reflection on retake requests, though little analysis has been performed with these tools so far.

The most exciting result in our research has been the consistent physics self-efficacy growth students experience in the course. We found that students' physics self-efficacy increased on average $(p < 0.001)$ across all sections surveyed, as shown in **Figure 1**. Digging deeper, it becomes clear that students without prior physics experience account for a substantial amount of the growth observed, meaning that students who are taking their first physics course *believe they can do physics*. This is contrary to what has been observed in some traditional physics instruction where students' physics self-efficacy generally decreases in a first-semester physics course (Dou et al., 2016; Henderson et al., 2020). This aligns with our hypothesis that taking advantage of mastery experiences will lead students to have a higher physics self-efficacy.

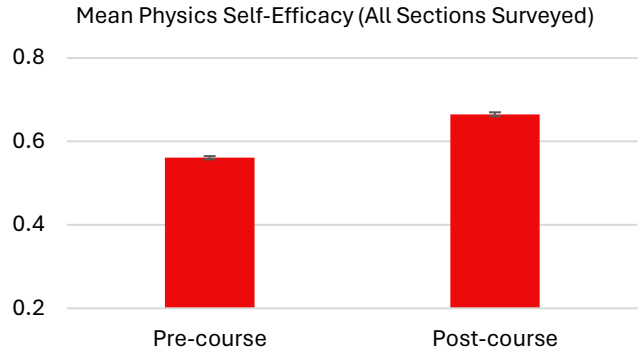

Figure 1: Physics self-efficacy on a scale from 0-1 from pre-and-post course surveys averaged across all three sections surveyed.

We also analyzed population differences in quiz mastery on their first attempt throughout the entire semester as shown in **Figure 2**. At the beginning of the course, there is a substantial difference between students with and without physics experience, with the starkest difference being in course week 4 where forces are introduced. By the end of the semester, there is no longer a statistically significant difference between the two groups, with the simple linear regression $(R^2 = 0.449)$ line $y = (0.05 \pm 0.02)x - (0.4 \pm 0.1)$ including zero within two standard errors at week 13. This relationship illustrates how students without physics experience are closing the gap with their peers in this course.

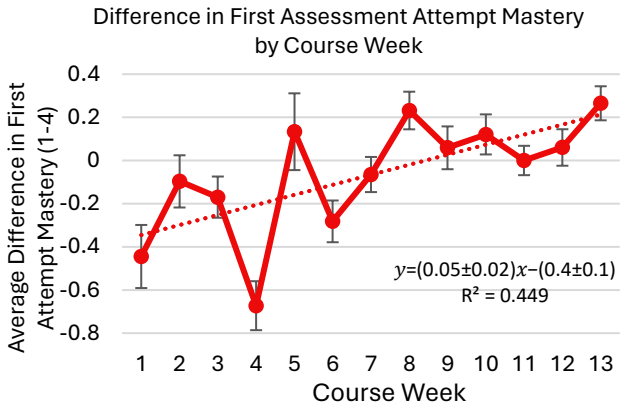

Figure 2: Average first assessment attempt mastery difference between students with and without physics experience versus course week.

SBA provides students with opportunities to reflect and grow from assessment and earn grades that better reflect their mastery of course material. In the last year, we have observed that students experienced self-efficacy growth while students without physics experience were able to close the performance gap with their peers. Overall, we have found evidence suggesting that SBA is an equitable approach to assessment in introductory physics, which is invaluable in a gateway course like Introduction to Physics and Biophysics I. In the future we plan to continue exploring other parts of the course implantation to improve the course curriculum for future students.

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